Supporting Information to "**Preparation of high-strength (Ta,W)C solid-solutions by spark plasma sintering**", by D. Demirskyi, K. Yoshimi, T.S. Suzuki, O. Vasylkiv, ***Int. J. Appl. Ceram. Technol.*** (2023) *https://doi.org/ 10.1111/ijac.14438*

Appendix

Supporting information, S1. *Diffusivity in the Ta-W-C system*

An alternative explanation for the porous areas in the vicinity of the W-spheres (main text, **Figure 12**) is due to a different diffusivity W/W when compared to W/TaC. Although the activation energy can be on the same level, the preexponential factor which contains only the frequency parameter responsible for the atom movement, or the diffusivity at a selected temperature is much slower for the TaC than W. This is because tungsten will have only metal bonds, while the carbide contains hybrid metal-ionic bonds that are one of the reasons behind the low diffusivity in the UHTC carbides [R1,R2]. Obviously, when comparing diffusivities, one should take into account the difference in the crystal cell type. W has a hexagonal closed packed cell while the UHTC carbides have a rock-salt cubic lattice. Ultimately, diffusion in W is the slowest one and the diffusivity has the same order of magnitude as ^{95}Zr diffusion in ZrC or ^{95}Nb in ZrC [R2], i.e., ~$5\cdot10^{-14}$ cm^2/s. The diffusivity of Ta in TaC has not been previously reported. This difference should create an additional gradient flux that may lead to the formation of the porosity [R3,R4].

The diffusivity at 2000°C was summarized in **Figure F1**, and the main values are: W self-diffusion ~ $4\cdot10^{-14}$ cm^2/s [R5,R6], C diffusion in TaC $1.5\cdot10^{-11}$ cm^2/s [R1], W diffusion in TaC $4\cdot10^{-12}$ cm^2/s [R2], and W diffusion in WC $3.9\cdot10^{-13}$ cm^2/s [R2].

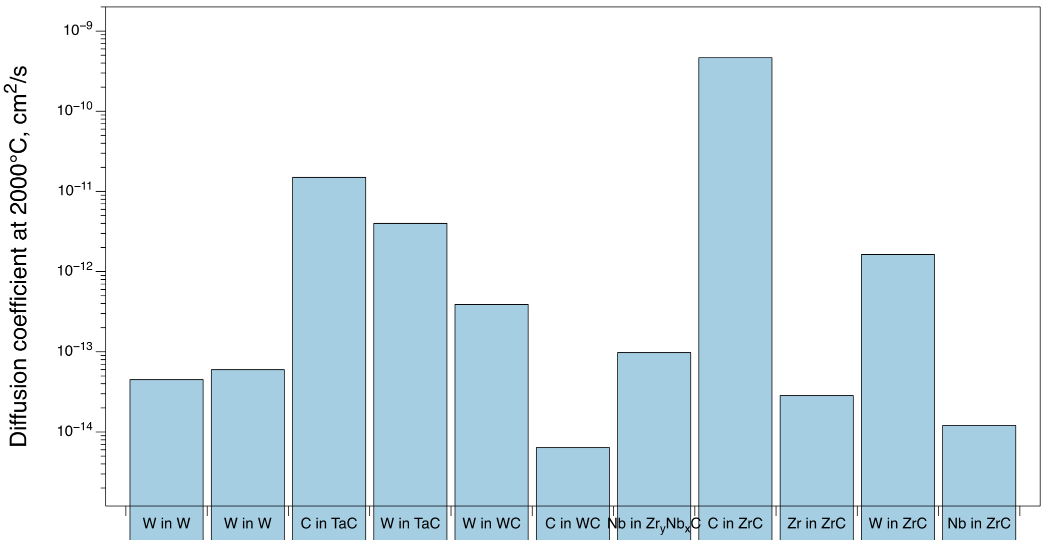

Figure F1. Data on the diffusivity in the selected materials at 2000 °C [R1,R2,R5,R6].

Supporting information, S2. *Fracture at various temperatures of 05TS ceramic*

Additional fracture of the 05TS ceramic is summarized in Figures **F2** and **F3**.

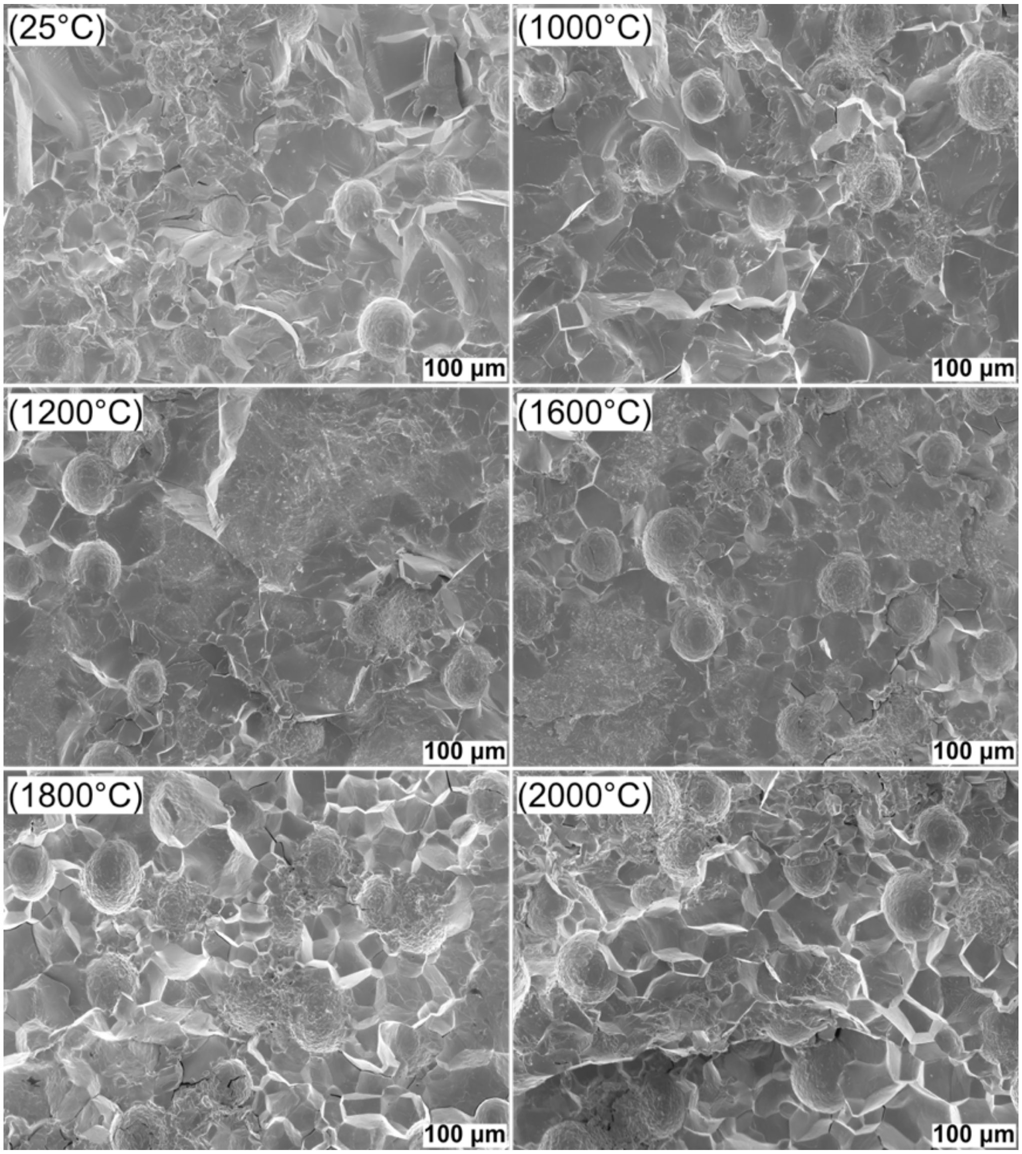

Figure F2. Effect of temperature of the flexural test on the fracture behavior of the (Ta,W)C ceramics. Compression goes from top to bottom. All images are acquired using SE.

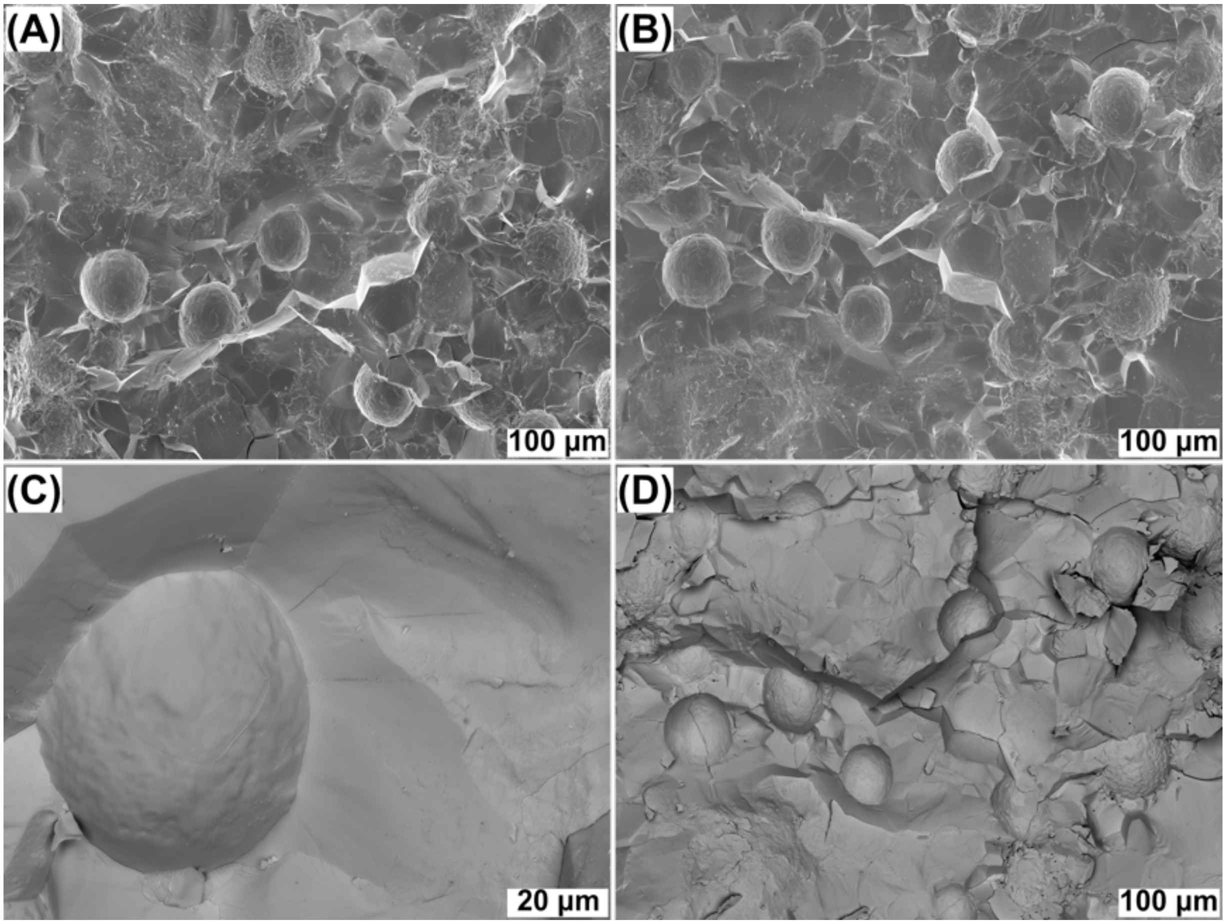

Figure F3. Fracture peculiarities for (Ta,W)C ceramics at 1200 °C. Fracture was observed near the tensile side for the fracture surface of the bar. The compression goes from top to bottom, while the crack propagates from bottom to top. (a,d) are acquired using the BSE mode. (a) and (b) are quasi-mirror images obtained on the opposite fracture surfaces.

References

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